Bois Reymond (in his Algemenie Functionentheorie). According to Prof. Veronese it is more proper to give an independent abstract account of the Fundamental Form, partly because the properties of the straight line are afterwards to be determined in accordance with abstract definitions. He therefore takes as a guide the rectilinear continuum of intuition, of whose properties he gives an analysis, and then proceeds in an abstract manner. He defines a Form as anything whose marks are part, whole, order, and kind of position. Thus a line regarded as consisting of segments limited by points in a certain order having positions on the line is a Form, a song regarded as consisting of certain words pronounced in a certain order and each in a certain musical pitch is a Form. He explains how one Form may be determined by other Forms, and how the identity of two Forms may be inferred from the identity of the Forms that severally determine them. To avoid the circular reasoning that must ensue, unless some Forms are known to be identical there arises the necessity for introducing the Fundamental Form as a standard which serves for the determination of all others. He describes successively a system of one dimension as a form given by a series of elements whose order, from a certain element, is a mark of the form, a homogeneous system of one dimension, and a system of one dimension identical in the positions of its parts. Such a form is chosen as Fundamental Form. The operations of uniting segments of the Form and of separating united segments are described, and shown to obey the Laws of Algebra for addition and subtraction. The relations of segments as multiples or factors of other segments lead to the laws of multiplication and division, and to the description of the Scale founded upon any segment as unit. The Range of the Scale (Gebiet der Scala) is the part of the Fundamental Form arrived at by continual repetition of the segment chosen as unit.

The author is now prepared to introduce the conceptions of the infinitely great and the infinitely small. He assumes that there is an element of the Fundamental Form which lies outside the Range of the Scale founded on any segment as unit. This assumption is apparently free from any contradiction. Such an element being chosen, the segment limited by it, and any element within the range of the scale, is infinitely great in reference to the unit of the scale; had this segment been chosen as unit, the original unit would have been infinitely small. From the nature of the Fundamental Form, as a homogeneous system identical in the position of its parts, follows the necessity of assuming any number of orders of infinite segments and any number of orders of infinitesimal segments.

To every segment corresponds a numerical symbol, just as in particular the natural numbers correspond to the segments which are exact multiples of that one chosen as unit. The ordinary Laws of Algebra holding for the segments hold in like manner for the numbers thus introduced. To the infinitely great and infinitely small segments of different orders correspond infinitely great and infinitely small numbers of different orders. It is proved that the numbers thus arrived at are not identical with Cantor's "Transfinite numbers" (*Acta Mathematica*, Bd. II.). After the introduction of these numbers, and the establishment of the laws of operation with them, come the hypotheses of continuity of the Fundamental Form, an idea here treated in a very instructive manner, the proof of the existence of Limits so elaborately discussed by Du Bois Reymond, the notions of commensurable and incommensurable segments, and the theory of Proportion, the last being especially interesting. A chapter is added for the sake of completeness, in which the properties of real, positive and negative, rational and irrational, numbers are established on the basis of principles already discussed.

It is a cardinal feature of the author's account of the theory of Quantity to dispense with the so-called Axiom V of Archimedes, according to which it is inherent in the notion of quantity that when one quantity a is greater than another b, there exists a number n such that nb is greater than a. This axiom has been found by other writers, as Stolz, extremely useful in establishing the properties and relations of finite quantities, but appears to involve difficulties in connection with the infinitely great and the infinitely small. At the expense of greater length of explanation, Prof. Veronese has freed the theory from the axiom and the involved difficulties. His own exposition is generally clear, though his doctrine of "commensurable numbers of the second kind" (pp. 182 and 213) is not without obscurity. Could not an example have been given?

Enough has been said to show that Prof. Veronese's book treats of a great deal besides the Foundations of Geometry—his Introduction might, in fact, well be entitled the Foundations of Mathematics. He tells us that although some parts of it will be useful in Geometry, much has been worked out simply for its own sake. We may well be grateful to him for the patience and trouble that he has expended in clearing up the Logic of the operations that most of us, without a thought of underlying difficulties, cheerfully perform with confidence and success. He has none of the charm of style to be found in the writings of Clifford or Kronecker. Rigorous he is, thoroughly common-sense, careful almost to tediousness, and extremely leisurely. For the elucidation of the very difficult subject he has chosen, these qualities are perhaps the greatest of merits, yet we fear that they will not render his writings acceptable to readers unprepared for a considerable sacrifice of time. A. E. H. L.

TEXT-BOOKS ON ORGANIC CHEMISTRY.

Organic Chemistry. Part I. By W. H. Perkin, jun., Ph.D., F.R.S., and F. Stanley Kipping, Ph.D., D.Sc. (London: W. and R. Chambers, 1894.)

Lessons in Organic Chemistry. Part I. Elementary. By G. S. Turpin, M.A. (Camb.), D.Sc. (Lond.) (London: Macmillan, 1894.)

IT is not surprising that "organic" chemistry should have received less attention in this country than on the continent, considering that the professors in nearly all the chief British universities have been notoriously neglectful of this department of the science, and that the highest degrees in connection with chemical science have been until recent years generally attainable without a practical acquaintance with the subject, and without evidence of capacity for research.

The influences which in Germany have led to so widespread and successful prosecution of research in organic chemistry are traceable partly to the university system, which demands the production of a piece of original work, and partly to the wonderful development in that country of the colour industry, which is now practically a German monopoly. We have, however, British chemists who have successfully devoted themselves to "organic" chemistry, and among them the names of Perkin (son as well as father) and Kipping stand out in honourable prominence. Hence a text-book issued in these conjoint names would naturally excite attention and interest.

"Our original intention," say the authors in their preface, "was to write a small text-book on organic chemistry, based on the syllabus drawn up by the Science and Art Department." Such a plan, however, was not worthy of the reputation of the writers, and they are to be congratulated upon having enlarged the scope of their work beyond this rather narrow limit.

This volume, Part I., deals with the fatty compounds, and "contains in the first place a general account of the methods most frequently employed in the separation, purification, and analysis of organic compounds, and in the determination of molecular weight. The preparation and properties of typical compounds are then described, attention being directed to those changes which come under the heading of general reactions rather than to isolated facts regarding particular substances. Questions of constitution are also discussed at some length, and in the case of the most typical compounds, the facts on which the given constitutional formula is based are specifically mentioned." From this outline it will be seen that the arrangement of the book is not essentially novel. The best feature is the discussion of the structure or constitution as expressed by the formulæ of the more important compounds, and, notwithstanding one or two statements which look rather dogmatic, this is the feature which gives it some superiority over other text-books of about the same dimensions. No reference is made in this volume to ideas of geometrical isomerism, which are prudently reserved for the second part. It is to be regretted that the authors should have allowed themselves to drop, in print, into the slovenly phraseology which is too common among all classes of chemists. For example, p. 99, cane sugar is said to be converted into "equal molecules" of dextrose and levulose. It is true that this expression is employed by writers of bigger books, but that is no justification for the continuance of a phrase which is absolutely unmeaning. On p. 204, triethylamine is said to be "a stronger base" than diethylamine; while on the opposite page, 205, tetrethylammonium hydroxide is stated to be "a stronger base" than potash or soda. If eminent chemists occupying the position of university professors are so lax, it is not to be wondered at that the poor South Kensington teacher and his pupils should be sometimes found wanting when called upon for definitions.

Chapter xiii., p. 218, opens with this statement:—

> "It may be assumed as a general rule that the changes which any particular group of atoms is capable of undergoing are independent of the nature of the groups with which it is combined."

This requires for its justification something more than the example which follows, for organic chemistry is full of instances of the influence which neighbouring atoms and groups have upon the character of a given atom or group; and at the top of the very same page the authors draw attention to one of these, namely: "The influence of alkyl groups in increasing the basic character of an element." Mercury is here referred to, and the meaning is obvious to the instructed chemical reader, though the reference to the basic character of the element, coupled with the succeeding statement that mercuric oxide is a feeble base, is well calculated to confuse the mind of a learner.

Dr. Turpin's book is one of the series of science class-books adapted to the elementary stage of the South Kensington syllabus, and issued by Macmillan. Here again the arrangement runs upon well-established lines, beginning with processes of analysis, methods of estimating molecular weight, and then plunging into the successive series of hydrocarbons, alcohols, ethers, acids, and so forth. Detailed directions are given for the performance of a selection of instructive experiments, the number of which, however, being no more than twenty in the whole book, ought to be considerably increased. At the end of each chapter are some questions which will doubtless be suggestive to both pupil and teacher. These are good and useful features of the book, which it must be remembered is labelled elementary; but, oh! Dr. Turpin, where in the whole range of stereo-chemical literature did you find the "valuable hypothesis" that "the carbon atom is regarded as being similar in shape to a regular tetrahedron"? (p. 31). We certainly feel justified in protesting against the author's treatment of the "tetrahedral theory of the carbon atom," which is disposed of in about twenty lines with three shaded diagrams. It is more than doubtful whether this hypothesis should appear in an elementary book at all, but to thrust it in without reference to the sort of fact which it is intended to explain, and to state it in this crude form, cannot be too strongly condemned.

Both these little books have their good points, and both will undoubtedly be found useful by many young students; but the perusal of them and others leaves the impression that the text-book which will meet all the difficulties and provide fully for the needs of the student entering upon this ever-widening subject of organic chemistry, has yet to be written. Organic chemistry is not begun till the student has some acquaintance with inorganic and general chemistry, and if properly taught previously he ought not to require to be told how to deduce a formula from the results of analysis, or how to determine a molecular weight. The practice of reserving these matters as an introduction to organic chemistry belongs to a bygone time, and it has the disadvantage of leading many students to think that vapour density and other methods are applicable only to organic compounds. The arrangement of carbon compounds in homologous series from the outset is also confusing to the beginner, because each succeeding term of such a series is derived from distinct materials which have no apparent connection with either those which go before or those which follow after. A better plan, adopted in some of the older books, now out of date, is first to study the transformations of some one substance, such as alcohol, which lends itself to many changes, which are easily traced experimentally, and subsequently to deal with series. This leads naturally and easily to the great object of the detailed study of carbon compounds. Apart from their practical utility and the application of knowledge gained by this detailed study to the purposes of the vegetable and animal physiologist, the great aim of the organic chemist is surely to trace the relation of chemical constitution to physical properties, and so to shed light upon the wider question of the constitution of matter generally; but this is just the aspect of the study which, in most of the text-books, is kept in the background. W. A. T.

PRACTICAL PHYSICS.

Physikalisches Prakticum, mit besonderer Berücksichtigung der physikalisch-chemischen Methoden. Von Eilhard Wiedemann und Hermann Ebert. Zweite verbesserte und vermehrte Auflage. Pp. xxiv. 455. 279 Woodcuts. (Braunschweig, Viewig, 1893.)

RECENT years have seen a great development in the teaching of practical physics, and a great increase in the number of laboratories in which instruction in the elementary parts of the subject can be given to large classes of students. So much has this been the case, that now practical physics is taught in a good many of our schools, and forms one of the subjects in numerous examinations. Those who have been largely concerned in the establishment of classes for practical instruction in physics, and have had some experience in actual teaching, have often felt the need of a suitable book to put into the hands of their students, and have endeavoured, each for himself, to supply this want. This is the origin of several books on practical physics, such as Glazebrook and Shaw's manual (to take an English example), and the work before us. The authors of such books are able to employ the MS. or the proof-sheets in the instruction of their students, and thus are able to obtain a practical test of their work before sending it forth to the public, with the result that the books are generally very satisfactory for the purposes for which they are designed. The only drawback is that each book is apt to appeal only to a particular type of students, and to give descriptions of the apparatus in a particular laboratory.

The "Practical Physics" of Wiedemann and Ebert has been designed for a special class of students, viz. those who are chiefly interested in acquiring a knowledge of chemistry. Particular attention has therefore been devoted to those parts of physics which are of most use in a study of chemistry, while several parts of the subject of great interest to physicists have been either omitted or only very briefly dealt with. Thus experiments on rigid dynamics and on the magnetic properties of iron and steel are completely passed over.

The authors have not attempted to give an account of the methods of precision which may be employed in the experiments selected by them, and consequently have taken no notice of the small corrections which become of so great importance in an accurate research. In those cases where it seemed desirable that some source of error should be brought prominently before the student's notice, the experiment is so arranged that the correction shall not be too small.

To each section there is an introduction wherein the general laws to be employed are stated, and the quantities to be measured are sometimes defined; but, as a rule, no account whatever is given of the reasoning by which the formulæ are arrived at. This is bound to be unsatisfactory, and must lead the student to be continually asking for explanations of the formulæ, unless indeed he be a person of little mental vigour, when he will accept formulæ without a murmur. In many instances no explanation or definition whatever of the quantity to be measured is vouchsafed to the student. For example, he is informed that the coefficient of viscosity of a liquid can be determined by the formula

$$\eta = \frac{\pi p r^4 t}{8 V l}$$

where V is the volume of liquid which is driven through a fine tube of radius r and length l in time t by a pressure p, but there is absolutely no definition of the coefficient of viscosity, although it might have been given in a few lines. The same complaint may be made about several other sections. The authors are surely mistaken in their idea that by their method the use of books on "the higher mathematics" may be dispensed with, and the "Prakticum" become a self-contained treatise on practical physics, wherein the student may find all he requires without the trouble of searching through special text-books. Besides, it is in every way better that the student should endeavour to acquaint himself with the methods by which the formulæ have been deduced. He gains in this way a grasp of the principles of the subject which is hardly attainable in any other manner; and if he does learn a little mathematics, he may hope that it will not seriously injure his ability for chemistry.

Before dealing with the contents of the book, it may be well to mention some points in which the book is far less satisfactory than the authors were capable of making it. The first complaint is that the results of the sample experiments are frequently set down without any statement of the units in which they are expressed. For instance, the modulus of rigidity of brass is found by an experiment to be 4770 *somethings*, but what the *somethings* are is not stated. The student who happened to express the linear magnitudes in centimetres instead of millimetres, would doubtless be much perplexed when he found by his experiment the value 477,000 instead of the result in the book. If, on the other hand, the value of the modulus had been expressed as 4770 kilogrammes per square millimetre, all the difficulty would have been avoided. The student should be so trained to state precisely the units in which his results are expressed, that the bare statement that the modulus of rigidity is 4770 should produce an unsatisfied feeling, in his mind, much the same as is called up by the conundrum, Why is a house? In some instances where units are given, they are given wrongly, as when the velocity of sound is found to be 331·5 *metres*, and the average velocity of hydrogen molecules is stated to be 1698 *metres*.

A minor defect is that one system of units is not